Applied Research Associates, Inc.

Long-Term Monitoring Sensor Network

Technology Need:

Long-term monitoring (LTM) associated with subsurface contamination sites is an expensive endeavor, often exceeding the costs of the remediation phase of a clean-up project. Most LTM requirements are mandated by federal or state regulation. The primary LTM costs are associated with labor. Sample collection, storage, preparation, analysis, and reporting can add a significant financial burden when extended over many years. Contamination of soil and groundwater can result in LTM programs ranging from 10 to 100 years or more. Monitored natural attenuation is increasingly important, requiring extensive LTM of a wide range of water quality, nutrient, and contaminant parameters. LTM costs may be significantly reduced through development of unattended, in situ monitoring networks capable of providing quantitative data satisfactory to regulatory concerns. Subsurface LTM is not in widespread use primarily because subsurface sensors all share a common obstacle: survival and dependable operation in a difficult environment. Deploying almost any sensor in the subsurface for extended periods of time will expose it to chemical and microbial degradation. Frequent replacement or servicing (cleaning) of sensors is expensive and labor intensive, offsetting most, if not all, of the cost savings realized with unattended, in situ sensors.

Technology Description:

Applied Research Associates, Inc. proposes to enable facile, remote monitoring of contaminants and other subsurface parameters over prolonged periods through the development of an advanced long-term monitoring sensor network. To meet this objective, three key elements will be developed and field tested:

1. An ***anti-fouling sensor chamber*** that can accommodate a variety of chemical and physical measurement devices based on electrochemical, optical, and other techniques. The chamber will be self-cleaning, in situ, yet removable from the subsurface so that the sensors can be exchanged in cases where their longevity is insufficient to meet extreme LTM requirements (e.g., 30 years or longer).

2. Two rapid, cost effective, and gentle means of emplacing sensor packages either at precise locations directly in the subsurface or in pre-existing monitoring wells. ***Wireline Cone Penetrometer*** (WirelineCPT) technology will be utilized for direct emplacement, whereas a ***packer-based chassis configuration*** will be used for emplacement within pre-existing monitoring wells. This technology will allow for continuous assessment of groundwater conditions at precisely placed, isolated depths along existing screened intervals.

3. A ***web browser-based data acquisition and control system*** (Web-DACS) utilizing field-networked microprocessor-controlled smart sensors housed in anti-fouling sensor chambers. The Web-DACS will employ multi-drop RS-485 serial communications and cable-based or wireless transmission to a central host computer to provide long-term, automated, and unattended operations with data available to users via the web in near real-time.

Once developed, the proposed long-term monitoring network will be highly versatile and can be applied to a variety of subsurface sensing scenarios.

Benefits:

‣The sensor chamber with integrated acoustic cleaning capability will reduce or eliminate the cost associated with retrieval for cleaning, sample collection, storage, preparation, analysis, and reporting.

‣The WirelineCPT system minimally disrupts the subsurface environment, resulting in minimal generation of investigation-derived waste, enhanced worker protection, increased speed, and lower cost.

‣Inflatable well packers will enable precise control of sensor positioning, allow continuous assessment of groundwater conditions at isolated depths along existing screened intervals, and enable multiple-level installations.

‣Unattended data acquisition will reduce data handling cost, improve quality by eliminating manual data handling errors, and improve worker safety by eliminating waste sample handling.

Status and Accomplishments:

To test reliability, communications protocol converters were installed in the field to acquire data for the duration of the project from ARA sensors of a pre-existing design. ARA selected the Institute of Electrical and Electronics Engineers standard 1451.2 as a software protocol for field data communications. Adherence with this protocol will ensure compatibility with a broad range of manufacturers' equipment and systems already in use for monitoring field sites and process facilities. ARA completed development of the logical and physical object model of the sensor network, covering all stages of the process from transduction to data retrieval.

ARA evaluated sensors to use for demonstration of the system concept and began testing the Orion pHuture Pentrode. After consulting with a sonication expert, ARA selected an ultrasonic transducer for use in laboratory testing. ARA developed test plans for laboratory studies of ultrasonic cleaning efficiency.

ARA is modifying the web browser-based data acquisition and control system. ARA completed design and began fabrication of test apparatus. ARA evaluated 2-way pager coverage at Savannah River and other DOE sites for considering telemetry options.

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Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 3161
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

For additional information, please visit Applied Research Associates, Inc.'s website at http://www.ara.com/